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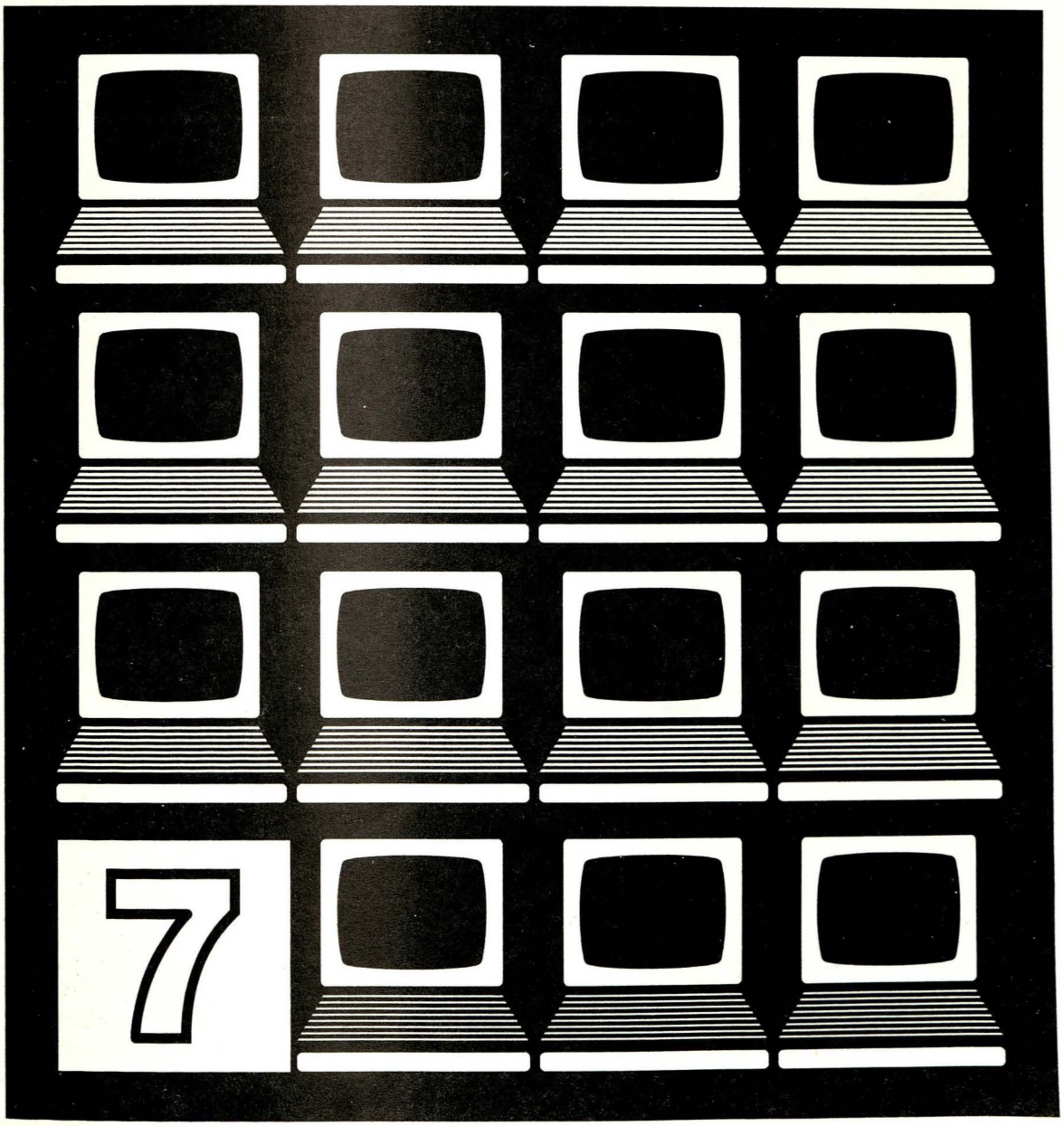
The Microcomputer Scientific Software Series 7

Data Recorder Program For Storing Plant Lists And Calculating Synecological Coordinates

Kevin Nimerfro and Gary Brand



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The Microcomputer Scientific Software Series 7: Data Recorder Program for Storing Plant Lists and Calculating Synecological Coordinates

Kevin Nimerfro and Gary Brand

Various approaches have been used to identify the underlying differences in terrestrial ecosystems and to use these differences in classifying ecosystems. Classification criteria have included plant species composition, soil taxonomic descriptions, soil chemical and physical properties, land form, and climate alone or in combination. Occurrence of plant species is the basis for one classification approach, the method of synecological coordinates (Bakuzis 1959, Bakuzis 1967, Bakuzis and Kurmis 1978, Brand 1985, Gutiérrez-Espeleta 1991). The method of synecological coordinates (referred to as MSC) has been useful in comparing the environmental requirements of herbaceous species (Bakuzis and Hansen 1962); relating pine reproduction to stand and site characteristics (Kurmis and Hansen 1969); comparing the environmental differences among forests, savannas, and prairies growing in a transition area (Drew 1974); identifying ecological types and their successional trends (Kurmis *et al.* 1986); distinguishing stands with different site indexes and soil productivity groups (Walters *et al.* 1989); and determining floristic classes with different productivities (Brand and Almendinger 1992). The purpose of the data recorder program presented here is to store the names of plant species observed and compute synecological coordinates while in the field.

MSC was developed for Minnesota's forest ecosystems (Bakuzis 1959). The coordinates provide semi-quantitative values for four fundamental ecosystem factors: moisture (M), nutrients (N), heat (H), and light (L). Each species has a value ranging from 1 to 5 for each factor, which indicates, on average, the amount of the factor found where that species occurs when competing with other plants. A value of 1 indicates a low level of the factor, and a value of 5 indicates a high level. For example, the light coordinate for the shade tolerant sugar maple (*Acer saccharum*) is 1 and the light coordinate for the shade intolerant tamarack (*Larix laricina*) is 5. An arithmetic mean of the values for those species occurring together is called a community coordinate. To illustrate, if only three species are found in a plot and they have light coordinates of 1, 3, and 2, then the community light coordinate is (1+3+2)/3 or 2. Generally at least 15 to 20 species are required to compute useful community coordinates. Thus, the community light coordinate where sugar maple is the dominant overstory species will usually be lower than where tamarack is dominant. Community coordinates also can be computed by weighting species values by abundance. A species twice as abundant as another would receive twice the weight in the computation. However, experience has shown that unweighted values indicate more clearly the stable aspects of the environment (Bakuzis and Kurmis 1978).

Plant species lists are required to compute community synecological coordinates. These lists can be collected in a number of ways depending on the size of the area being evaluated and the prospective use of the community coordinates. A common method for collecting plant lists is to sample a number of small, fixed-size plots located within each ecologically homogeneous area of interest. At each plot the species of each plant present is recorded and the species' synecological coordinates are added to the plot's total for each factor. When coordinates are computed by presence, additional individuals of a species are ignored. Likewise, when computing synecological coordinates for the entire area, i.e. all plots,

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coordinates for a species are used only once even if it is present on many of the plots. Community synecological coordinates for a plot are obtained by dividing the plot total by the number of species present in the plot. Community synecological coordinates for the entire area are calculated in a like manner using the total of the coordinates and count of species. Example computations are shown in table 1. These computations are time consuming, tedious, and prone to errors, especially when many species are encountered or many plots are used.

Table 1.—*Sample calculations of the community light coordinate when a location contains three species*

Species	Plot 1	Plot 2	Area
	------ *Light coordinate* -----		
A	1	–	1
B	–	3	3
C	2	2	2
Total	3	5	6
Number of species	2	2	3
Community coordinate	1.5	2.5	2.0

A field data recorder simplifies species list collection, stores the lists for later analysis, and quickly computes synecological coordinates while still in the field. Duplicate species are automatically removed from the list, eliminating one common error in compiling species lists and computing synecological coordinates. Incorrect assignment of species synecological coordinates is also avoided because coordinates are automatically recalled from a stored list. A data recorder equipped with a bar code wand can be a good alternative to a keyboard in some situations. DR SYCO (Data Recorder program for SYnecological COordinates) is the program designed to carry out these tasks.

The following sections show how the program would appear when used in the field, describe the capabilities needed in the data recorder, and explain how to obtain a copy of the program.

USING THE PROGRAM

Before DR SYCO can be used, four files must be loaded into the data recorder. The first file, *main.exe*, is the program. It uses the second file, *beep.exe*, to sound a tone on the data recorder when a species code has been successfully entered with a bar code wand. Species codes and their synecological coordinates are stored in a third file, *spp.dat*. The synecological coordinates contained in *spp.dat* have been calibrated for Minnesota (Appendix). Species codes can contain up to eight characters. In the *spp.dat* provided, the first four characters of the genus and first four characters of the specific epithet form the species code. Duplicate codes are eliminated by replacing the last character with a unique digit. For example, *Galium trifidum* is coded as GALITRI1 and *Galium triflorum* is coded as GALITRI2. As synecological coordinates become available for other locations, additional species data files can be created. Or, if common names are preferred, eight-character species codes for common names can be created and used in *spp.dat*. The entries in this file must be sorted alphabetically by species code and can contain values for up to 600 species. Currently there are 523 species stored in *spp.dat* (Appendix). The last file is *s.bat*. It executes a series of commands needed to properly run the program.

To start DR SYCO, type **S** and press **ENTER**. In about a minute the first screen (fig. 1a) appears. This is how the main menu appears when the data recorder does not contain any previously recorded species lists. The main menu changes somewhat (fig. 1b) if previously recorded species lists are stored in the data recorder. Species lists for up to 50 different locations can be stored and displayed. Press the **F1** key to return to the previous screen. Pressing **F1** when at the main menu will exit the program. Enter up to eight characters for the name of your location, press **ENTER**, and verify that this is a new location by pressing **Y**. On the second screen (fig. 2a), enter a two-character identifier for the first plot, press **ENTER**, and verify that this is a new plot by pressing **Y**. As in the main menu, the screen is modified (fig. 2b) if this is not the location's first plot. From 1 to 20 plots can be recorded at each location. If you want to make a note about the location, press the **F2** key to open an empty screen that has room for 168 characters. **F1** will exit the note screen.

Figure 1a

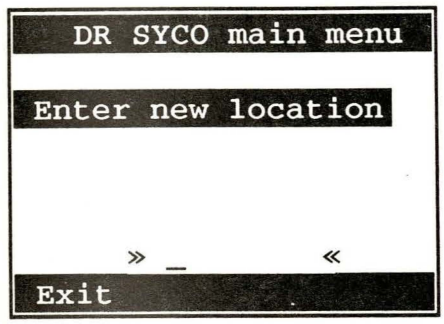


Figure 1b

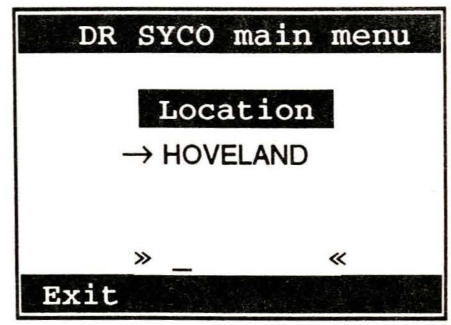


Figure 1.—*The appearance of the main menu screen when no species lists are stored in the data recorder (1a) and when one species list is stored in the data recorder (1b).*

Figure 2a

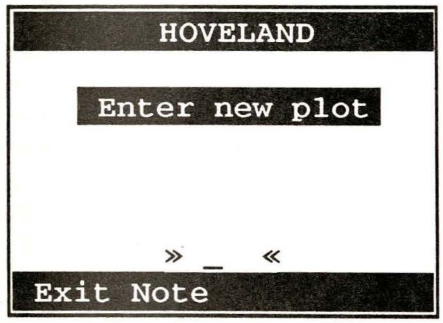


Figure 2b

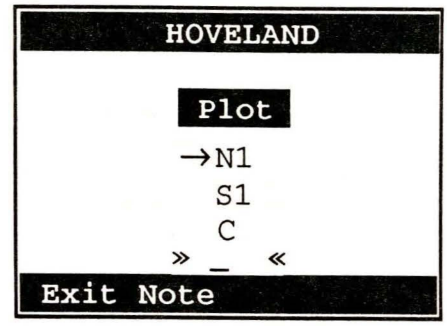


Figure 2.—*The plot entry/selection screen without any plots entered (2a) and when at least three plots are entered (2b).*

Figure 3a shows the screen used to enter species codes. Identify the first plant on the plot and begin entering its eight-character species code from the data recorder keyboard. The list on the right will scroll as you enter the characters. When the appropriate code appears to the right of the → on the screen, press **ENTER**. You may also scroll through the list with the keyboard's up and down arrows until you locate the correct code. If a code is entered that is not in the list, the program will ask for confirmation before the unknown code is entered in the "Found" list. Unknown codes do not have synecological coordinates so they are not used in calculating community coordinates. Identify the remaining plants on the plot and enter them also. A maximum of 75 species can be entered for a plot and up to 100 species can be entered for a location (series of plots).

When using a bar code wand, press ← (left arrow key) and the screen shown in figure 3b will appear. Identify the first plant on the plot, locate its bar code on a preprinted species list, and scan the bar code. A correct scan will sound a beep and enter the species code into the "Found" list. If you don't hear a beep within several seconds, try scanning again. The keyboard can also be used during wand entry if a bar code is not available for a species. Just use the → (right arrow key) to change to keyboard entry and the ← to return to wand entry. The wand entry screen can also be used to delete unwanted species codes. Use the up or down arrow keys to locate the species to remove and press the "del" key.

Figure 3a

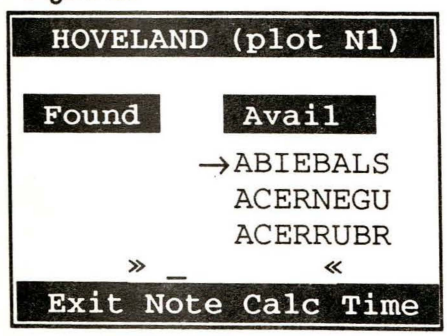


Figure 3b

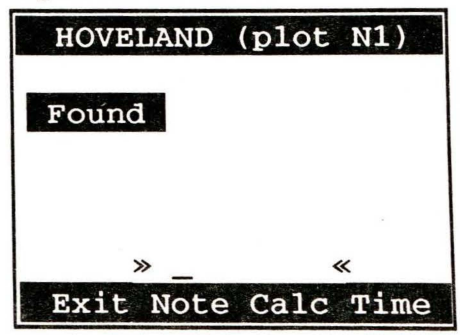


Figure 3.—*Species entry screen with no species entered. Keyboard entry uses the screen shown in 3a and bar code entry uses 3b.*

Figure 4.—*Synecological coordinate calculation screen for the plot (4a) and the location (4b).*

Figure 4a

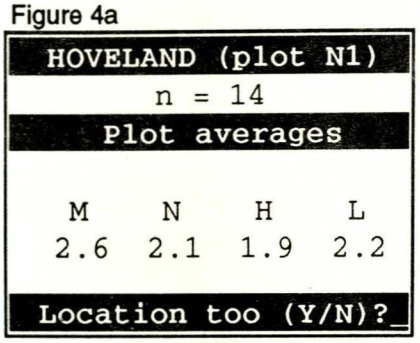
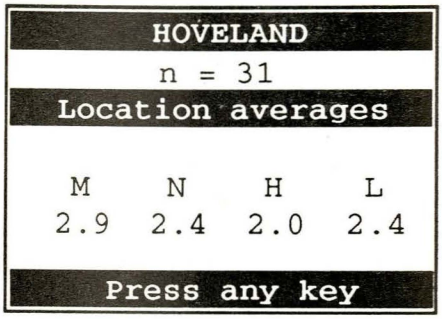


Figure 4b



Community synecological coordinates are calculated for the plot and for the location by pressing the **F3** key. The plot calculation screen (fig. 4a) shows the calculated values for the coordinates and the number of species used in the calculation. A similar screen is presented for the location (fig. 4b). As mentioned above, coordinates are computed by presence (unweighted).

The date and times of data collection are automatically entered for future reference. To see them (fig. 5), press the **F4** key from the species entry screen. The final time is set when you exit from the species entry screen, and it does not change if you later add or remove species from the plot. The current time is displayed if **F4** is pressed before the plot is exited.

Figure 5

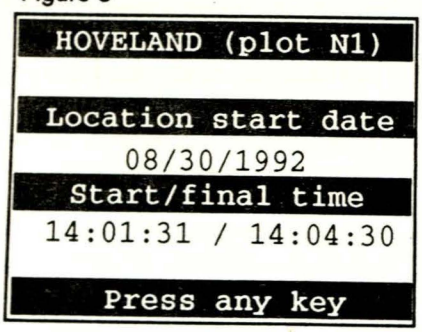


Figure 5.—*Display of date and time screen.*

When the program is terminated by successively pressing **F1**, a data file is created for new locations or for those with changes. The location name and the extension .SCD designate the data file. The data file can be used by other programs or loaded into a data base. An example showing the data file format is presented in figure 6.

DATA RECORDER REQUIREMENTS

There are many commercially available data recorders (Nieman and Scale 1992). DR SYCO is written in True BASIC and compiled on an MS-DOS compatible microcomputer. Therefore, the data recorder needs to be able to run compiled MS-DOS programs and execute common MS-DOS commands. DR SYCO requires about 125 KB of storage and 256 KB RAM to run. The species/synecological coordinate list takes about 10 KB of storage. Data files for each location typically require 1 to 3 KB of storage. Ports, cables, and software are also needed to download the files required to run DR SYCO and upload data files from the data recorder to the microcomputer.

A screen size of 8 lines by 21 characters is used by DR SYCO. Only the upper left portion of larger screens will be used. An internal clock and a keyboard with alphanumeric keys, function keys, and DOS control keys are required. The data recorder must support a bar code wand capable of deciphering alphanumeric bar codes if the bar code entry feature of DR SYCO is used.

HOW TO OBTAIN THE PROGRAM

Obtain the compiled program at no cost by sending a formatted (MS-DOS) disk to:

Modeling - DR SYCO
North Central Forest Experiment Station
1992 Folwell Avenue
St. Paul, MN 55108

A printed copy of bar codes for the species codes listed in the Appendix can be obtained from the authors. We use Code 39 bar codes, a common symbology used when alphanumeric characters need to be coded.

```
"HOVELAND"                                                    Location.
"19920830"                                                    Date (YYYYMMDD).
"LOCATED OFF ARROWHEAD"                                       Notes (8 lines).
"TRAIL                    "
"T62N R4W SEC 5           "
"SW1/4 SE1/4 NE1/4        "
"                         "
"                         "
"                         "
"                         "
 5                                                            Number of plots.
"N1","S1","C ","N2","S2",                                     Plot names.
"14:01:31","14:15:37","14:28:16","14:39:27","14:50:09",       Start times.
"14:04:30","14:22:51","14:34:25","14:45:51","14:58:56",       Finish times.
 31                                                           Number of species.
"ABIEBALS",1,1,1,1,1,                                         Species code,
"ATHYFILI",1,0,0,0,0,                                         present (1),
"ACERSPIC",1,1,1,1,1,                                         absent (0),
"CORYCORN",1,0,1,0,1,                                         on each plot.
"RUBUPARV",1,1,0,1,1,
"MAIACANA",1,1,1,1,0,
"ASTEMACR",1,1,1,1,1,
"ARALNUDI",1,1,1,1,0,
"MITENUDA",1,1,0,0,1,
"GALITRI2",1,0,0,0,0,
"DIERLONI",1,0,0,0,0,
"TRIEBORE",1,1,0,0,0,
"AMELSPP.",1,0,0,0,0,
"STREROSE",1,1,1,1,1,
"CLINBORE",0,1,1,0,1,
"ANEMQUIN",0,1,0,1,1,
"LONICANA",0,0,0,0,1,
"PICEGLAU",0,1,0,1,0,
"CORNSTOL",0,1,0,0,0,
"LONIHIRS",0,0,1,0,1,
"POPUTREM",0,0,1,0,0,
"RUBUPUBE",0,0,0,1,1,
"TRILGRAN",0,0,0,1,0,
"PRUNVIRG",0,0,0,1,0,
"ACERSAC2",0,0,0,1,0,
"BETUPAPY",0,0,0,1,0,
"DRYOSPIN",0,0,0,0,1,
"GALIBORE",0,0,0,0,1,
"FRAXNIGR",0,0,0,0,1,
"LONICANA",0,1,0,0,0,
"GYMNDRYO",0,0,0,1,1,
```

Figure 6.—*The format of the species list file. Comments in bold are informational and are not part of the file. The name of this file is HOVELAND.SCD.*

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APPENDIX

DR SYCO (Data Recorder program for SYnecological COordinates) reads a comma-delimited data file (*spp.dat*) containing the species code and synecological coordinates (M,N,H, and L) for the following Minnesota species. Nomenclature follows Crum (1983), Gleason (1963a, 1963b, 1963c), Ownbey and Morley (1991), and the Soil Conservation Service (1982a, 1982b). The list contains synonymies of outdated but frequently used names.

Species	Code	M	N	H	L
Abies balsamea	ABIEBALS	4	2	1	2
Acer negundo	ACERNEGU	3	5	5	3
Acer rubrum	ACERRUBR	2	2	3	3
Acer sac1charinum	ACERSAC1	3	5	5	4
Acer sac2charum	ACERSAC2	3	5	3	1
Acer spicatum	ACERSPIC	3	2	2	1
Achillea lanulosa	ACHILANU	1	1	3	2
Achillea mil1lefolium	ACHIMIL1	3	3	3	5
Achillea mil2lefolium subsp. lanulosa	ACHIMIL2	1	1	3	2
Actaea pachypoda	ACTAPACH	3	4	2	1
Actaea rubra	ACTARUBR	3	3	2	1
Adiantum pedatum	ADIAPEDA	2	5	4	1
Agastache foeniculum	AGASFOEN	2	2	3	4
Agastache scrophulariaefolia	AGASSCRO	3	5	4	3
Agrimonia gryposepala	AGRIGRYP	2	3	4	2
Agrimonia striata	AGRISTRI	2	2	3	3
Allium stellatum	ALLISTEL	2	3	4	5
Alnus crispa	ALNUCRIS	2	1	1	4
Alnus incana	ALNUINCA	5	2	1	4
Alnus rugosa	ALNURUGO	5	2	1	4
Alnus viridis	ALNUVIRI	2	1	1	4
Amblystegium spp.	AMBLSPP.	3	2	1	2
Amelanchier alnifolia	AMELALNI	2	3	2	4
Amelanchier humilis	AMELHUMI	2	3	3	3
Amelanchier laevis	AMELLAEV	3	3	4	3
Amelanchier sanguinea	AMELSANG	2	2	2	4
Amelanchier spp.	AMELSPP.	3	2	2	4
Amerorchis rotundifolia	AMERROTU	4	4	1	4
Amorpha canescens	AMORCANE	1	1	4	5

Amorpha fruticosa	AMORFRUT	2	2	5	4
Amphicarpaea bracteata	AMPHBRAC	3	2	4	3
Anaphalis margaritacea	ANAPMARG	1	2	2	5
Andromeda glaucophylla	ANDRGLAU	5	1	1	5
Anemone canadensis	ANEMCANA	3	2	2	4
Anemone cylindrica	ANEMCYLI	2	2	3	5
Anemone quinquefolia	ANEMQUIN	4	3	3	4
Anemone riparia	ANEMRIPA	3	4	3	3
Anemone virginiana	ANEMVIRG	2	2	3	4
Antennaria canadensis	ANTECANA	1	1	2	5
Antennaria neglecta	ANTENEGL	2	2	4	5
Antennaria neo1dioica	ANTENEO1	1	2	3	4
Antennaria neo2dioica subsp. canadensis	ANTENEO2	1	1	2	5
Antennaria plantaginifolia	ANTEPLAN	1	2	3	5
Apocynum androsaemifolium	APOCANDR	1	2	3	5
Apocynum cannabinum	APOCCANN	2	2	3	4
Aquilegia canadensis	AQUICANA	1	3	3	4
Aralia hispida	ARALHISP	2	2	2	4
Aralia nudicaulis	ARALNUDI	2	2	2	3
Aralia racemosa	ARALRACE	3	5	4	1
Arctium minus	ARCTMINU	2	2	3	5
Arctostaphylos uva-ursi	ARCTUVA-	1	1	2	5
Arisaema atrorubens	ARISATRO	3	5	4	1
Arisaema triphyllum	ARISTRIP	3	5	4	1
Artemisia campestris subsp. caudata	ARTECAMP	1	2	3	5
Artemisia ludoviciana	ARTELUDO	1	2	4	4
Asarum canadense	ASARCANA	4	5	3	1
Asclepias syriaca	ASCLSYRI	2	2	4	5
Asclepias tuberosa	ASCLTUBE	1	3	5	5
Asparagus officinalis	ASPAOFFI	2	2	3	5
Aster borealis	ASTEBORE	4	3	2	4
Aster ciliolatus	ASTECILI	2	2	2	4
Aster cordifolius	ASTECORD	2	2	4	4
Aster ericoides	ASTEERIC	1	2	4	5
Aster junciformis	ASTEJUNC	4	3	2	4
Aster laevis	ASTELAEV	1	2	3	5
Aster lanceolatus	ASTELANC	3	2	3	4
Aster lateriflorus	ASTELATE	2	2	3	4

Aster macrophyllus	ASTEMACR	2	2	2	3
Aster novae-angliae	ASTENOVA	3	2	3	4
Aster ontarionis	ASTEONTA	2	3	3	4
Aster oolentangiensis	ASTEOOLE	1	2	4	5
Aster puniceus	ASTEPUNI	4	2	2	4
Aster sagittifolius	ASTESAGI	2	2	2	4
Aster simplex	ASTESIMP	3	2	3	4
Aster umbellatus	ASTEUMBE	2	2	3	4
Athyrium angustum	ATHYANGU	3	3	2	1
Athyrium filix-femina	ATHYFILI	3	3	2	1
Athyrium thelypterioides	ATHYTHEL	3	5	4	1
Berteroa incana	BERTINCA	2	3	3	5
Betula alleghaniensis	BETUALLE	4	5	2	2
Betula glandulifera	BETUGLAN	5	1	1	5
Betula nigra	BETUNIGR	3	4	4	4
Betula papyrifera	BETUPAPY	3	2	2	5
Betula pumila	BETUPUMI	5	1	1	5
Bidens cernua	BIDECERN	4	2	3	5
Botrychium multifidum	BOTRMULT	3	3	2	3
Botrychium virginianum	BOTRVIRG	4	4	3	1
Bromus inermis	BROMINER	2	4	3	3
Brotherella recurvans	BROTRECU	3	2	1	2
Calla palustris	CALLPALU	5	2	1	5
Calopogon tuberosus	CALOTUBE	5	2	3	5
Caltha palustris	CALTPALU	5	2	2	4
Campanula americana	CAMPAMER	4	4	4	4
Campanula apa1rinoides	CAMPAPA1	4	3	4	4
Campanula apa2rinoides var. grandiflora	CAMPAPA2	4	2	2	3
Campanula rotundifolia	CAMPROTU	2	2	3	4
Campanula ulignosa	CAMPULIG	4	2	2	3
Cardamine parviflora	CARDPARV	2	2	3	4
Carex pensylvanica	CAREPENS	1	2	3	4
Carpinus caroliniana	CARPCARO	2	5	5	1
Carya cordiformis	CARYCORD	3	5	5	1
Carya ovata	CARYOVAT	4	5	5	1
Caulophyllum thalictroides	CAULTHAL	3	5	4	1
Ceanothus americanus	CEANAMER	1	1	2	5
Ceanothus herbaceus	CEANHERB	1	1	2	4

Celastrus scandens	CELASCAN	1	3	3	4
Celtis occidentalis	CELTOCCI	3	5	5	2
Cetraria islandica	CETRISLA	1	1	1	5
Chamaedaphne calyculata	CHAMCALY	5	1	1	5
Chenopodium album	CHENALBU	2	3	4	5
Chenopodium simplex	CHENSIMP	2	3	3	3
Chimaphila umbelellata	CHIMUMBE	1	1	2	4
Cicuta bulbifera	CICUBULB	4	2	2	4
Cicuta maculata	CICUMACU	4	2	3	4
Circaea alpina	CIRCALPI	4	3	2	1
Circaea lutetiana	CIRCLUTE	4	5	4	1
Circaea quadrisulcata	CIRCQUAD	4	5	4	1
Cirsium altissimum	CIRSALTI	3	1	4	4
Cirsium arvense	CIRSARVE	2	2	3	5
Cirsium hillii	CIRSHILL	1	2	3	5
Cirsium muticum	CIRSMUTI	4	3	3	2
Cladina ran1giferina	CLADRAN1	1	1	1	5
Cladonia ran2giferina	CLADRAN2	1	1	1	5
Claytonia caroliniana	CLAYCARO	3	4	3	3
Claytonia virginica	CLAYVIRG	3	4	4	3
Clematis occidentalis	CLEMOCCI	3	4	3	4
Clematis virginiana	CLEMVIRG	3	3	4	3
Climacium americanum	CLIMAMER	3	3	2	2
Clintonia borealis	CLINBORE	3	2	1	2
Comandra umbellata	COMAUMBE	2	3	3	4
Comptonia peregrina	COMPPERE	1	1	2	5
Convolvulus arvensis	CONVARVE	2	2	2	5
Convolvulus spithamaeus	CONVSPIT	1	2	3	4
Conyza canadensis	CONYCANA	2	3	3	5
Coptis groenlandica	COPTGROE	4	2	1	1
Corallorhiza maculata	CORAMACU	2	3	3	3
Corallorhiza trifida	CORATRIF	3	2	2	3
Cornus alternifolia	CORNALTE	2	5	4	1
Cornus canadensis	CORNCANA	3	2	1	2
Cornus foemina subsp. racemosa	CORNFOEM	1	4	4	3
Cornus racemosa	CORNRACE	1	4	4	3
Cornus rugosa	CORNRUGO	2	3	3	2
Cornus stolonifera	CORNSTOL	4	2	2	3

Corylus americana	CORYAMER	1	2	3	5
Corylus cornuta	CORYCORN	2	1	2	3
Corydalis sempervirens	CORYSEMP	1	2	3	4
Crataegus spp.	CRATSPP.	3	5	4	4
Cryptotaenia canadensis	CRYPCANA	3	5	5	2
Cynoglossum boreale	CYNOBORE	3	4	2	3
Cypripedium acaule	CYPRACAU	3	2	2	3
Cypripedium calceolus	CYPRCALC	3	3	3	3
Cypripedium reginae	CYPRREGI	4	3	3	2
Cystopteris bulbifera	CYSTBULB	4	3	3	2
Cystopteris fragilis	CYSTFRAG	3	4	2	2
Desmodium glutinosum	DESMGLUT	2	5	4	1
Dicranum polysetum	DICRPOLY	3	2	1	2
Dicranella spp.	DICRSPP.	3	2	1	2
Diervilla lonicera	DIERLONI	1	2	2	3
Dirca palustris	DIRCPALU	3	5	4	1
Dracocephalum parviflorum	DRACPARV	3	3	3	4
Drosera rotundifolia	DROSROTU	5	2	1	5
Dryopteris carthusiana	DRYOCART	4	2	1	1
Dryopteris cristata	DRYOCRIS	4	2	1	3
Dryopteris disjuncta	DRYODISJ	4	3	1	1
Dryopteris phegopteris	DRYOPHEG	4	3	1	1
Dryopteris spinulosa	DRYOSPIN	4	2	1	1
Dryopteris thelypteris	DRYOTHEL	5	2	1	1
Empetrum nigrum	EMPENIGR	4	1	1	5
Epigaea repens	EPIGREPE	1	1	2	5
Epilobium angustifolium	EPILANGU	3	2	2	5
Epilobium glandulosum	EPILGLAN	3	2	1	5
Epilobium leptophyllum	EPILLEPT	4	2	3	4
Epilobium palustre	EPILPALU	4	2	1	5
Equisetum arvense	EQUIARVE	4	2	2	1
Equisetum fluviatile	EQUIFLUV	5	2	2	5
Equisetum hyemale	EQUIHYEM	2	2	1	5
Equisetum palustre	EQUIPALU	4	2	1	5
Equisetum pratense	EQUIPRAT	1	2	2	5
Equisetum scirpoides	EQUISCIR	4	2	1	2
Equisetum sylvaticum	EQUISYLV	3	2	1	3
Erigeron canadensis	ERIGCANA	2	3	3	5

Erigeron glabellus	ERIGGLAB	1	1	2	4
Erigeron philadelphicus	ERIGPHIL	4	4	3	3
Euonymus atropurpuereus	EUONATRO	3	5	4	4
Eupatorium maculatum	EUPAMACU	4	4	3	3
Euthamia graminifolia	EUTHGRAM	3	3	3	5
Fragaria vesca	FRAGVESC	3	3	2	4
Fragaria virginiana	FRAGVIRG	2	2	2	4
Fraxinus nigra	FRAXNIGR	4	3	3	2
Fraxinus pennsylvanica	FRAXPENN	3	5	4	4
Funaria hygrometrica	FUNAHYGR	2	4	2	5
Galeopsis tetrahit	GALETETR	3	2	2	5
Galium aparine	GALIAPAR	3	4	3	2
Galium asprellum	GALIASPR	5	3	2	1
Galium boreale	GALIBORE	1	2	2	5
Galium labradoricum	GALILABR	5	2	1	3
Galium tinctorium	GALITINC	2	5	1	2
Galium tri1fidum	GALITRI1	5	2	2	4
Galium tri2florum	GALITRI2	3	2	2	1
Gaultheria hispidula	GAULHISP	5	1	1	3
Gaultheria procumbens	GAULPROC	1	1	2	5
Geranium bicknellii	GERABICK	2	3	2	4
Geranium maculatum	GERAMACU	3	3	4	3
Geum canadense	GEUMCANA	3	4	3	2
Geum macrophyllum	GEUMMACR	3	3	2	3
Geum rivale	GEUMRIVA	4	2	2	3
Gleditsia triacanthos	GLEDTRIA	3	5	5	3
Goodyera repens	GOODREPE	3	2	2	3
Goodyera tesselata	GOODTESS	2	2	2	3
Gymnocladus dioica	GYMNDIOI	3	5	4	4
Gymnocarpium dryopteris	GYMNDRYO	4	3	1	1
Habenaria obtusata	HABEOBTU	5	1	1	1
Habenaria orbiculata	HABEORBI	4	1	1	2
Halenia deflexa	HALEDEFL	3	3	1	2
Helianthus divaricatus	HELIDIVA	1	2	4	4
Helianthus maximiliani	HELIMAXI	2	3	3	5
Helianthus rigidus	HELIRIGI	1	2	3	4
Helianthus strumosus	HELISTRU	2	3	5	4
Hepatica acutiloba	HEPAACUT	3	5	4	1

Hepatica americana	HEPAAMER	1	3	3	2
Heracleum lanatum	HERALANA	3	4	4	2
Heracleum maximum	HERAMAXI	3	4	4	2
Heuchera richardsoni	HEUCRICH	2	2	2	3
Hieracium canadense	HIERCANA	1	2	3	4
Hieracium kalmii	HIERKALM	1	2	3	4
Hieracium scabrum	HIERSCAB	1	2	2	5
Hydrophyllum virginianum	HYDRVIRG	4	5	5	2
Hypericum canadense	HYPECANA	3	2	3	4
Hypericum majus	HYPEMAJU	3	2	3	4
Ilex verticillata	ILEXVERT	4	2	3	4
Impatiens capensis	IMPACAPE	4	5	4	1
Impatiens pallida	IMPAPALL	4	5	4	2
Iris versicolor	IRISVERS	5	2	2	5
Isopyrum biternatum	ISOPBITE	4	5	5	3
Juglans cinerea	JUGLCINE	3	5	5	1
Juglans nigra	JUGLNIGR	2	5	5	2
Juncus tenuis	JUNCTENU	3	2	2	4
Juniperus communis var. depressa	JUNICOMM	1	1	2	5
Juniperus horizontalis	JUNIHORI	1	1	3	5
Juniperus virginiana	JUNIVIRG	1	3	5	3
Kalmia polifolia	KALMPOLI	5	1	1	5
Krigia biflora	KRIGBIFL	2	3	4	4
Lactuca biennis	LACTBIEN	3	3	2	4
Lactuca canadensis	LACTCANA	2	3	3	4
Lactuca serriola	LACTSERR	2	3	3	4
Laportea canadensis	LAPOCANA	4	5	5	1
Larix laricina	LARILARI	5	1	1	5
Lathyrus ochroleucus	LATHOCHR	1	2	3	5
Lathyrus palustris	LATHPALU	4	2	2	3
Lathyrus venosus	LATHVENO	1	2	2	5
Lechea intermedia	LECHINTE	1	1	3	5
Ledum groenlandicum	LEDUGROE	5	1	1	5
Leonurus cardiaca	LEONCARD	2	2	3	5
Leucobryum glaucum	LEUCGLAU	2	1	1	2
Liatris aspera	LIATASPE	1	2	4	5
Lilium philadelphicum	LILIPHIL	2	3	3	4
Linaria vulgaris	LINAVULG	1	2	3	5

Linnaea borealis	LINNBORE	3	2	1	3
Lithospermum canescens	LITHCANE	1	2	4	5
Lithospermum caroliniense	LITHCARO	1	2	4	5
Lobelia spicata	LOBESPIC	1	2	3	5
Lonicera canadensis	LONICANA	3	2	2	1
Lonicera dioica	LONIDIOI	1	2	3	5
Lonicera hirsuta	LONIHIRS	3	2	2	3
Lonicera oblongifolia	LONIOBLO	4	2	2	3
Lonicera villosa	LONIVILL	4	2	2	5
Lupinus perennis	LUPIPERE	3	3	4	3
Lychnis alba	LYCHALBA	3	3	4	2
Lycopus americanus	LYCOAMER	4	2	4	5
Lycopodium annotinum	LYCOANNO	4	2	1	1
Lycopodium clavatum	LYCOCLAV	3	1	2	1
Lycopodium complanatum	LYCOCOMP	2	2	2	3
Lycopodium lucidulum	LYCOLUCI	4	2	2	2
Lycopodium obscurum	LYCOOBSC	2	3	1	2
Lycopus uniflorus	LYCOUNIF	4	3	3	2
Lysimachia ciliata	LYSICILI	3	3	2	4
Lysimachia thyrisiflora	LYSITHYR	4	2	1	5
Maianthemum canadense	MAIACANA	1	2	2	4
Matteuccia struthiopteris var. pensylvanica	MATTSTRU	3	5	4	1
Medicago sativa	MEDISATI	2	3	3	5
Melampyrum lineare	MELALINE	1	1	3	5
Melilotus alba	MELIALBA	3	5	3	5
Menispermum canadense	MENICANA	3	5	5	3
Mentha arvensis	MENTARVE	3	3	2	4
Mertensia paniculata	MERTPANI	3	5	2	3
Mitchella repens	MITCREPE	2	3	3	3
Mitella diphylla	MITEDIPH	3	4	3	2
Mitella nuda	MITENUDA	4	2	1	1
Mnium spp.	MNIUSPP.	3	4	2	1
Monarda fistulosa	MONAFIST	1	2	3	3
Moneses uniflora	MONEUNIF	4	2	2	5
Monotropa uniflora	MONOUNIF	2	3	1	2
Muhlenbergia glomerata	MUHLGLOM	4	2	4	5
Myrica gale	MYRIGALE	5	2	1	5
Nepeta cataria	NEPECATA	2	2	3	5

Onoclea sensibilis	ONOCSENS	4	4	3	3
Onosmodium molle	ONOSMOLL	1	3	4	5
Opuntia humifusa	OPUNHUMI	1	3	5	5
Opuntia macrorhiza	OPUNMACR	1	3	5	5
Oryzopsis asperifolia	ORYZASPE	2	2	2	3
Oryzopsis pungens	ORYZPUNG	3	2	2	4
Osmorhiza claytonii	OSMOCLAY	3	5	3	1
Osmorhiza longistylis	OSMOLONG	3	5	4	1
Osmunda cinnamomea	OSMUCINN	4	2	1	1
Osmunda claytoniana	OSMUCLAY	2	5	5	2
Osmunda regalis	OSMUREGA	5	3	3	2
Ostrya virginiana	OSTRVIRG	2	5	4	1
Oxalis spp.	OXALSPP.	2	3	5	3
Parnassia palustris	PARNPALU	4	2	1	5
Parthenocissus quinquefolia	PARTQUIN	3	3	4	3
Pedicularis canadensis	PEDICANA	1	1	3	5
Penstemon gracilis	PENSGRAC	2	3	2	4
Petasites frigidus	PETAFRIG	4	2	1	3
Petasites palmatus	PETAPALM	4	2	1	3
Phryma leptostachya	PHRYLEPT	3	5	5	3
Physocarpus opulifolius	PHYSOPUL	3	3	3	2
Physalis virginiana	PHYSVIRG	2	4	5	5
Picea glauca	PICEGLAU	3	2	1	2
Picea mariana	PICEMARI	4	1	1	3
Pilea fontana	PILEFONT	4	2	3	5
Pinus banksiana	PINUBANK	1	1	2	5
Pinus resinosa	PINURESI	1	2	2	4
Pinus strobus	PINUSTRO	2	2	2	3
Plantanthera dilatata	PLANDILA	4	2	2	3
Plantanthera hookeri	PLANHOOK	1	2	3	3
Plantanthera hyperborea	PLANHYPE	4	2	2	4
Plantago major	PLANMAJO	2	3	3	5
Plantanthera obtusata	PLANOBTU	5	1	1	1
Plantanthera orbiculata	PLANORBI	4	1	1	2
Pleurozium schreberi	PLEUSCHR	2	2	1	2
Poa pal2ustris	POA PAL2	3	3	3	4
Podophyllum peltatum	PODOPELT	3	5	5	1
Pogonia ophioglossoides	POGOOPHI	4	2	3	5

Polygonatum canaliculatum	POLYCANA	2	5	5	5
Polygonum cilinode	POLYCILI	2	3	3	3
Polygonatum com1mutatum	POLYCOM1	2	5	5	5
Polytrichum com2mune	POLYCOM2	4	2	1	4
Polytrichum juniperinum	POLYJUNI	2	2	1	3
Polygala paucifolia	POLYPAUC	3	3	3	3
Polygonum pensylvanicum	POLYPENS	3	3	4	2
Polygonatum pubescens	POLYPUBE	3	5	4	2
Polygonum sagittatum	POLYSAGI	4	2	3	5
Polygonum scandens	POLYSCAN	3	2	4	3
Polygala senega	POLYSENE	2	3	4	3
Polypodium virginianum	POLYVIRG	2	1	1	3
Populus balsamifera	POPUBALS	4	3	2	3
Populus deltoides	POPUDELT	3	5	5	4
Populus grandidentata	POPUGRAN	1	3	3	3
Populus tremuloides	POPUTREM	2	2	2	4
Potentilla arguta	POTEARGU	2	2	3	5
Potentilla fruticosa	POTEFRUT	4	2	2	5
Potentilla norvegica	POTENORV	2	3	2	4
Potentilla palustris	POTEPALU	5	1	1	5
Potentilla recta	POTERECT	2	3	3	4
Potentilla tridentata	POTETRID	2	2	1	5
Prenanthes alba	PRENALBA	2	3	1	3
Prunus americana	PRUNAMER	2	3	4	3
Prunus nigra	PRUNNIGR	3	4	4	3
Prunus pensylvanica	PRUNPENS	1	2	3	5
Prunus pumila	PRUNPUMI	1	2	1	5
Prunus serotina	PRUNSERO	2	3	4	3
Prunus virginiana	PRUNVIRG	2	3	3	4
Pteridium aquilinum var. latiusculum	PTERAQUI	1	2	2	4
Pyrola asarifolia	PYROASAR	3	4	2	2
Pyrola chlorantha	PYROCHLO	2	3	2	3
Pyrola elliptica	PYROELLI	2	2	3	3
Pyrola rotundifolia	PYROROTU	2	2	2	3
Pyrola secunda	PYROSECU	2	2	2	3
Pyrola virens	PYROVIRE	2	3	2	3
Quercus alba	QUERALBA	2	5	5	2
Quercus ellipsoidalis	QUERELLI	1	2	3	5

Quercus macrocarpa	QUERMACR	1	3	4	3
Quercus rubra	QUERRUBR	1	4	3	3
Quercus velutina	QUERVELU	2	3	4	4
Ranunculus flabellaris	RANUFLAB	5	3	4	5
Ranunculus pensylvanicus	RANUPENS	4	2	3	5
Ranunculus recurvatus	RANURECU	2	3	3	3
Rhamnus alnifolius	RHAMALNI	5	1	2	4
Rhus glabra	RHUSGLAB	1	3	4	5
Rhus radicans	RHUSRADI	1	3	3	4
Rhus typhina	RHUSTYPH	1	2	3	3
Rhus vernix	RHUSVERN	4	2	4	3
Rhytidiadelphus triquetrus	RHYTTRIQ	3	3	2	2
Ribes americanum	RIBEAMER	3	5	3	2
Ribes cynosbati	RIBECYNO	3	4	4	2
Ribes glandulosum	RIBEGLAN	4	2	1	2
Ribes hirtellum	RIBEHIRT	4	2	2	3
Ribes hudsonianum	RIBEHUDS	5	2	2	4
Ribes lacustre	RIBELACU	4	2	2	2
Ribes missouriense	RIBEMISS	2	3	4	3
Ribes odoratum	RIBEODOR	3	3	4	4
Ribes oxyacanthoides	RIBEOXYA	3	2	1	4
Ribes triste	RIBETRIS	4	3	1	2
Robinia pseudoacacia	ROBIPSEU	3	2	5	4
Rosa acicularis	ROSAACIC	1	2	3	5
Rosa arkansana	ROSAARKA	2	3	4	4
Rosa blanda	ROSABLAN	1	2	2	5
Rubus acaulis	RUBUACAU	4	2	1	2
Rubus allegheniensis	RUBUALLE	3	2	2	5
Rubus flagellaris	RUBUFLAG	1	3	4	4
Rubus idaeus var. strigosus	RUBUIDAE	3	2	2	3
Rubus occidentalis	RUBUOCCI	3	3	3	4
Rubus parviflorus	RUBUPARV	3	2	2	3
Rubus pubescens	RUBUPUBE	4	2	1	1
Rubus strigosus	RUBUSTRI	3	2	2	3
Rudbeckia hirta	RUDBHIRT	3	3	4	4
Rudbeckia laciniata	RUDBLACI	4	5	4	3
Rudbeckia serotina	RUDBSERO	3	3	4	4
Rumex acetosella	RUMEACET	2	2	3	5

Rumex orbiculatus	RUMEORBI	4	2	2	4
Sagittaria latifolia	SAGILATI	5	2	4	5
Salix amygdaloides	SALIAMYG	4	2	3	4
Salix bebbiana	SALIBEBB	2	2	3	4
Salix candida	SALICAND	5	2	1	4
Salix discolor	SALIDISC	4	1	2	5
Salix exigua	SALIEXIG	2	3	2	5
Salix gracilis	SALIGRAC	4	3	2	5
Salix humilis	SALIHUMI	1	2	3	4
Salix interior	SALIINTE	2	3	2	5
Salix lucida	SALILUCI	4	2	2	5
Salix nigra	SALINIGR	4	5	4	4
Salix pedicellaris	SALIPEDI	5	1	1	5
Salix pyrifolia	SALIPYRI	4	2	1	2
Sambucus canadensis	SAMBCANA	2	5	4	1
Sambucus pubens	SAMBPUBE	3	5	3	3
Sanguinaria canadensis	SANGCANA	2	3	4	1
Sanicula marilandica	SANIMARI	2	3	3	3
Sarracenia purpurea	SARRPURP	5	2	1	5
Saxifraga pensylvanica	SAXIPENS	4	2	3	4
Scheuchzeria palustris	SCHEPALU	5	2	2	5
Schizachne purpurascens	SCHIPURP	3	3	2	3
Scutellaria galericulata	SCUTGALE	3	3	3	3
Scutellaria lateriflora	SCUTLATE	4	3	3	4
Selaginella rupestris	SELARUPE	1	1	4	4
Senecio pauperculus	SENEPAUP	1	2	3	5
Shepherdia canadensis	SHEPCANA	2	4	2	4
Silene latifolia	SILELATI	3	3	4	2
Sium suave	SIUMSUAV	4	3	3	4
Smilax herbacea	SMILHERB	2	5	4	2
Smilax hispida	SMILHISP	2	5	5	4
Smilax lasioneura	SMILLASI	3	5	5	3
Smilacina racemosa	SMILRACE	3	5	4	1
Smilacina stellata	SMILSTEL	2	5	4	3
Smilax tamnoides var. hispida	SMILTAMN	2	5	5	4
Smilacina trifolia	SMILTRIF	4	2	2	4
Solidago canadensis	SOLICANA	2	2	2	5
Solidago flexicaulis	SOLIFLEX	3	5	3	1

Solidago gigantea	SOLIGIGA	4	3	3	4
Solidago graminifolia	SOLIGRAM	3	3	3	5
Solidago hispida	SOLIHISP	2	2	3	4
Solidago juncea	SOLIJUNC	1	2	2	4
Solidago missouriensis	SOLIMISS	1	3	4	5
Solidago nemoralis	SOLINEMO	1	2	3	5
Sonchus arvensis	SONCARVE	3	3	2	5
Sorbus americana	SORBAMER	4	2	1	1
Sparganium eurycarpum	SPAREURY	5	3	4	5
Sphagnum spp.	SPHASPP.	5	1	1	5
Spirea alba	SPIRALBA	4	3	3	3
Spiranthes lacera	SPIRLACE	2	2	3	4
Stachys palustris	STACPALU	4	3	2	4
Staphylea trifolia	STAPTRIF	3	5	4	4
Stellaria longifolia	STELLONG	4	3	3	4
Streptopus roseus	STREROSE	2	3	3	1
Symphoricarpos albus	SYMPALBU	1	2	3	5
Symphoricarpos occidentalis	SYMPOCCI	2	4	5	5
Taraxacum officiniale	TARAOFFI	2	2	3	5
Taxus canadensis	TAXUCANA	4	3	2	1
Teucrium canadense	TEUCCANA	3	3	3	3
Thalictrum dasycarpum	THALDASY	4	3	3	4
Thalictrum dioicum	THALDIOI	2	3	3	3
Thaspium barbinode	THASBARB	3	4	3	3
Thelypteris palustris	THELPALU	5	2	1	1
Thelypteris phegopteris	THELPHEG	4	3	1	1
Thuja occidentalis	THUJOCCI	4	2	1	1
Tiarella cordifolia	TIARCORD	3	4	2	2
Tilia americana	TILIAMER	2	5	4	1
Trientalis borealis	TRIEBORE	4	2	1	1
Trifolium pratense	TRIFPRAT	2	3	3	5
Trifolium repens	TRIFREPE	2	3	4	4
Triglochin maritima	TRIGMARI	5	4	4	5
Trillium cernuum	TRILCERN	3	5	3	1
Trillium grandiflorum	TRILGRAN	3	5	4	2
Tsuga canadensis	TSUGCANA	4	3	1	1
Typha latifolia	TYPHLATI	5	3	3	5
Ulmus americana	ULMUAMER	3	5	4	2

Ulmus rubra	ULMURUBR	3	5	5	3
Ulmus thomasii	ULMUTHOM	2	5	5	4
Urtica dioica	URTIDIOI	4	5	5	1
Utricularia vulgaris	UTRIVULG	5	1	3	5
Uvularia grandiflora	UVULGRAN	2	5	4	1
Uvularia sessilifolia	UVULSESS	2	4	3	1
Vaccinium angustifolium	VACCANGU	1	1	1	5
Vaccinium myrtilloides	VACCMYRT	2	1	1	4
Vaccinium oxycoccus	VACCOXYC	5	1	1	5
Vaccinium vitis-idea var. minus	VACCVITI	5	1	1	5
Verbena hastata	VERBHAST	3	3	4	5
Verbascum thapsus	VERBTHAP	2	3	3	4
Veronica americana	VEROAMER	5	3	3	5
Veronoicastrum virginicum	VEROVIRG	3	5	5	4
Viburnum edule	VIBUEDUL	3	2	2	3
Viburnum lentago	VIBULENT	3	5	5	2
Viburnum rafinesquianum	VIBURAFI	2	2	3	3
Viburnum trilobum	VIBUTRIL	3	3	3	3
Vicia americana	VICIAMER	3	3	4	3
Vicia cracca	VICICRAC	2	3	3	5
Viola adunca	VIOLADUN	1	1	2	4
Viola canadensis	VIOLCANA	4	2	2	1
Viola conspersa	VIOLCONS	3	5	4	1
Viola incognita	VIOLINCO	3	2	2	3
Viola macloskeyi subsp. pallens	VIOLMACL	4	3	2	3
Viola pallens	VIOLPALL	4	3	2	3
Viola pedata	VIOLPEDA	1	2	4	5
Viola pubescens	VIOLPUBE	2	2	2	3
Viola renifolia	VIOLRENI	3	3	2	2
Viola rotundifolia	VIOLROTU	3	5	3	3
Viola rugulosa	VIOLRUGU	4	2	2	1
Viola sororia	VIOLSORO	3	3	3	2
Vitis riparia	VITIRIPA	2	5	5	5
Waldsteinia fragarioides	WALDFRAG	3	3	3	4
Woodsia ilvensis	WOODILVE	1	1	2	1
Zanthoxylum americanum	ZANTAMER	2	5	5	1
Zizia aptera	ZIZIAPTE	2	3	3	3
Zizia aurea	ZIZIAURE	3	4	4	5

Nimerfro, Kevin; Brand, Gary.
1993. **The microcomputer scientific software series 7: Data recorder program for storing plant lists and calculating synecological coordinates**. Gen. Tech Rep. NC-157. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 20 p.

Describes a computer program, designed for data recorders that stores plant lists and computes synecological coordinates from the stored list. The method of synecological coordinates uses plant species present on a site to quantify the site's environmental factors.

KEY WORDS: Environmental factors, Minnesota, forest ecosystems, BASIC.

Our job at the North Central Forest Experiment Station is discovering and creating new knowledge and technology in the field of natural resources and conveying this information to the people who can use it. As a new generation of forests emerges in our region, managers are confronted with two unique challenges: (1) Dealing with the great diversity in composition, quality, and ownership of the forests, and (2) Reconciling the conflicting demands of the people who use them. Helping the forest manager meet these challenges while protecting the environment is what research at North Central is all about.

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